Appl. No. 10/769,388
Amdt. dated February 27, 2007
Reply to Office Action of October 4, 2006

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Amendments to the Claims:

This listing of claims will replace all prior versions, and listings of claims in the application:

Listing of Claims:

1.   (Currently amended) A translation lookaside buffer system for translating virtual addresses to physical addresses, the system comprising:

an input arbitration module configured to receive translation requests from a plurality of clients, each translation request including a target virtual address, the input arbitration module further configured to select one of the translation requests for processing;

a primary cluster store having a plurality of locations, each location configured to store a cluster, wherein each cluster provides a mapping to a respective physical address for each virtual address in a range of virtual address space, ~~and~~ wherein the respective ranges of different ones of the clusters have different sizes, ~~wherein each location in the primary cluster store is further configured to store range size information for the cluster stored therein~~ and wherein each cluster includes a plurality of references to blocks of physical addresses such that the virtual addresses in the range mapped by the cluster are mapped to the blocks of physical addresses;

a primary lookup logic circuit coupled to receive the selected translation request from the input arbitration module and configured to associate one of the locations in the primary cluster store with the selected translation request, thereby designating the associated location for storing a target cluster whose range includes the target virtual ~~address,~~ address; and

~~wherein the primary cluster store is further configured such that the range size information for the designated location is set to a value representing a minimum range size in the event that the target cluster is not stored in the designated location at the time the association of the designated location to the translation request is made and such that the range size information is set to a value representing an actual range size of the target cluster when the target cluster is loaded into the designated location; and~~

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a translation module configured to translate the target virtual address of the selected translation request to a physical address based at least in part on the mapping provided by the cluster stored in the primary cluster store location associated with the selected translation request.

2.   (Previously presented) The translation lookaside buffer system of claim 1, further comprising:

a primary tag store coupled to the primary lookup logic circuit and configured to store a tag corresponding to each location in the primary cluster store, wherein each tag encodes the range of the virtual address space mapped by the cluster in the corresponding primary cluster store location,

wherein the primary lookup logic circuit is further configured to detect a primary cache hit in the event that the target virtual address of the selected translation request matches one of the tags in the primary tag store and to detect a primary cache miss otherwise.

3.   (Original) The translation lookaside buffer system of claim 2, wherein each of the plurality of clients is allocated a non-overlapping portion of the primary tag store.

4.   (Original) The translation lookaside buffer system of claim 3, wherein one of the plurality of clients generates translation requests for a plurality of address streams, and wherein the portion of the primary tag store allocated to the one of the clients is subdivided among the address streams.

5.   (Original) The translation lookaside buffer system of claim 2, wherein the primary lookup logic circuit is further configured to respond to a primary cache hit by associating the location in the primary cluster store that corresponds to the matched tag with the selected translation request.

6.   (Original) The translation lookaside buffer system of claim 5, further comprising a secondary cluster cache configured to respond to a detected primary cache miss by

obtaining a cluster based on the target virtual address and storing the obtained cluster in the primary cluster store.

7.   (Original) The translation lookaside buffer system of claim 6, wherein the secondary cluster cache includes:

a secondary cluster store configured to store a plurality of clusters;

a secondary tag store configured to store a secondary tag corresponding to each cluster stored in the secondary cluster store, wherein each secondary tag encodes a range of virtual addresses mapped by the corresponding cluster; and

a secondary lookup logic circuit configured to receive the target virtual address and to identify a matching one of the secondary tags in the secondary tag store, wherein the range of virtual addresses encoded by the matching secondary tag includes the current target virtual address.

8.   (Original) The translation lookaside buffer system of claim 7, wherein the secondary cluster cache further includes:

a cluster fetch circuit configured to receive the target virtual address in the event that a matching secondary tag is not identified by the secondary lookup logic circuit and to obtain a cluster corresponding to the target virtual address from a cluster table.

9.   (Original) The translation lookaside buffer system of claim 7, wherein a non-overlapping portion of the secondary tag store is allocated to each client.

10.   (Previously presented) The translation lookaside buffer system of claim 2, wherein the primary lookup logic circuit is further configured to store a new primary tag for the current target address in the primary tag store in the event of a primary cache miss, thereby designating a location in the primary cluster cache for storing a new cluster corresponding to the new primary tag, wherein the new primary tag encodes the minimum range size of the virtual address space.

11. (Previously presented) The translation lookaside buffer system of claim 10, wherein upon storing the new cluster in the primary cluster cache, the new primary tag is updated to reflect the actual range size of virtual addresses for which the new cluster provides a mapping.

12. (Original) The translation lookaside buffer system of claim 1, further comprising a buffer module configured to receive translation requests from the primary lookup logic circuit and to store the received translation requests for subsequent forwarding to the translation module.

13. (Original) The translation lookaside buffer of claim 12, wherein the primary lookup logic circuit is further configured to process a selected translation request before the cluster for a previously selected translation request is present in the primary cluster store location associated with the previously selected translation request.

14. (Original) The translation lookaside buffer system of claim 12, wherein the buffer module includes a separate request queue for each of the plurality of clients.

15. (Original) The translation lookaside buffer system of claim 14, wherein the request queues are configured such that a sequential order of receipt among translation requests from a same one of the clients is preserved and a sequential order of receipt among translation requests from different ones of the clients is not preserved.

16. (Previously presented) The translation lookaside buffer system of claim 12, further comprising:

a ready logic circuit configured to identify as a ready request at least one translation request stored in the buffer module for which a cluster is present in the associated location in the primary cluster store and

a selection circuit configured to select one of the ready requests and to provide the selected ready request to the translation module.

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17.   (Original) The translation lookaside buffer system of claim 1, wherein the input arbitration module is further configured to select a translation request based at least in part on availability of downstream resources needed to process each translation request.

18.   (Original) The translation lookaside buffer system of claim 17, wherein the needed downstream resources include a storage location in the primary cluster store.

19.   (Original) The translation lookaside buffer of claim 17, wherein the input arbitration module is further configured to determine whether the needed downstream resources are available or not available based at least in part on which of the clients generated the proposed request.

20.   (Original) The translation lookaside buffer system of claim 1, wherein the translation requests received from the clients include a first request from a first one of the clients, the first request having a transparent translation mode, and wherein the system further comprises:

a memory interface circuit configured to transmit a memory access request corresponding to the first request to a system memory device, the memory access request including the physical address provided by the translation module in response to the first request.

21.   (Original) The translation lookaside buffer system of claim 20, wherein the translation requests received from the clients further include a second request from a second one of the clients, the second request having a visible translation mode, and wherein the memory interface circuit is further configured to transmit to the second client the physical address provided by the translation module in response to the second request.

22.   (Currently amended) A method for translating virtual addresses to physical addresses, the method comprising the acts of:

defining a plurality of clusters ~~in designated locations in a primary cluster store~~, wherein each cluster provides a mapping to a respective physical address for each virtual address in a range of virtual address space, ~~and~~ wherein respective sizes of the ranges mapped by different ones of the clusters are different<u>, and wherein each cluster includes a plurality of</u>

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references to blocks of physical addresses such that the virtual addresses in the range mapped by the cluster are mapped to the blocks of physical addresses;

receiving a first translation request from a client, the first translation request including a first target virtual address;

storing a first tag in a tag store, the first tag encoding a minimum size range of the virtual address space that includes the first target virtual address, ~~in the event that the first cluster is not stored in a first location of a primary cluster store identified by the first tag such that the largest virtual address that can be translated by the first cluster is associated with the minimum size of the virtual address space, the first tag further encoding an actual size range of the virtual address space that includes the first target virtual address in the event that the first cluster is stored in the first location of the primary cluster store such that the largest virtual address that can be translated by the first cluster is associated with the actual size of the virtual address space~~ the first tag further identifying a first location in the primary cluster store;

associating the first request with the first location in the primary cluster store;

fetching ~~the~~ a first cluster that maps a range of the virtual address space that includes the first target virtual address into the first location in the primary cluster store; and

translating the first target virtual address to a physical address based at least in part on the mapping provided by the first cluster.

23.   (Currently amended) The method of claim 22, wherein the act of fetching the first cluster includes the acts of:

~~in the event that the first cluster is not stored in the primary cluster store,~~ searching for the corresponding cluster in a secondary cluster cache based on the target virtual address; and

in the event that the corresponding cluster is not found in the secondary cluster cache, fetching the corresponding cluster from a cluster table.

24.   (Cancelled)

25.   (Original) The method of claim 22, further comprising the acts of:

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subsequently to receiving the first translation request, receiving a second translation request from the client, the second translation request including a second target virtual address;

determining whether the second target virtual address matches the first tag; and

in the event that the second target virtual address matches the first tag:

associating the second request with the first location in the primary cluster store;

retrieving the first cluster from the first location in the primary cluster store; and

translating the second target virtual address to a physical address based at least in part on the mapping provided by the first cluster.

26.   (Original) The method of claim 22, further comprising:

determining whether the first translation request is in a transparent translation mode or a visible translation mode;

in the event that the first translation request is in the transparent translation mode, transmitting a corresponding memory access operation to a system memory device, wherein the corresponding memory access operation includes the translated physical address; and

in the event that the first translation request is in the visible translation mode, transmitting the translated physical address to the client.

27.   (New) The method of claim 22, further comprising the act of:

subsequently to storing the first tag, modifying the first tag to encode the range of the virtual address space mapped by the first cluster.